Neuropsychological Correlates of Frontal Behavioral Syndromes

in Individuals with Traumatic Brain Injury.

By

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Abstract

The primary purpose of this study was to evaluate whether putative subsystem-specific measures of frontal/executive functioning (dorsolateral, orbital, and medial frontal subsystems) would be related in a unique manner with specific frontally-based personality sub-types. 45 adults who had sustained traumatic brain injury were administered a battery of neuropsychological tests of frontal lobe functioning and a measure of general conceptual ability. Brain injured participants and collaterals completed the Frontal Lobe Personality Scale (FLOPS), a questionnaire designed to evaluate the presence and severity of behaviour and personality change following frontal lobe injury. Contrary to hypothesis, no significant relationships were found between putative measures of frontal lobe functioning and ratings on the FLOPS. Results provide some support for the hypothesis of reduced awareness of deficit among traumatically brain-injured patients. However, tests of frontal lobe functioning were not predictive of the degree unawareness of deficit among brain-injured patients, over and above measures of general conceptual ability. Limitations of the present study and avenues for further research are discussed.

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Introduction

An enormous body of research has accumulated over the past decade examining impairments in cognitive functioning in individuals who have sustained traumatic brain injury (Parker, 1993). This literature has provided strong evidence documenting significant post-injury deficits in cognitive ability with impairments in attention, memory, and executive functioning being most pronounced (Sohlberg, Mateer, & Stuss, 1993; Mattson & Levin, 1990). More recently, researchers have begun to examine the behavioral and emotional changes that frequently co-occur with cognitive difficulties following traumatic brain injury (TBI). These changes in behavior and emotional functioning encompass a heterogenous range. For example, Stuss and Gow (1992) provide a "partial listing" comprising some 40 descriptors. As noted by Goldstein and Levin (1989), these clusters of deficits are often difficult to define, conceputalize, and measure objectively.

The construct *personality* can be defined as:

> "patterns of emotional and motivational responses that develop over the life of the organism; are highly influenced by early life experiences; are modifiable, but not easily changed, by behavioral or teaching methods; and greatly influence (and are influenced by) cognitive processes… (Prigatano et al., 1986, p. 30).

Using this definition, the term *personality* is highly related to similar terms including mood, psychosocial functioning, and behavioral adjustment. Defined in this broad manner, changes in personality and behavioral functioning following TBI have been documented in a number of recent studies (see Prigatano, 1992 for review).

This research has demonstrated that changes in personality following TBI have been shown to have a profound impact on patients' progress in recovery, in their quality of life, and their long-term outcome (Lezak & O'Brien, 1988). Some studies have shown that personality change is often of greater importance in determining a person's long-term outcome than are deficits in cognitive functioning (Miller, 1993; McClelland, 1988). Based on a four-year outcome study, Lezak (1987) concluded that emotional and personality changes are perceived by both patients and family members as being more debilitating than both the cognitive and physical limitations resulting from the injury.

Based on a review of this literature, Prigatano (1992) enumerated the 25 most commonly reported disturbances in personality seen in moderate-to-severe TBI patients. Following Eames's (1988) taxonomy, problems were classified in terms of *active* versus *passive* syndromal patterns. *Active* syndrome symptoms included irritability, agitation, belligerence, anger, impulsiveness, and emotional lability. Symptoms associated with a *passive* syndromal pattern included aspontaneity, loss of drive or initiative, and depressed affect.

Personality changes have been reported by up to 75% of family members of TBI survivors five years post-injury (Brooks, Campsie, & Symington, 1986). Families of brain-injured survivors report more personality changes than any other problems at both 1 and 5 years post injury (Brooks et. al, 1986, and often consider these to be the most distressing aspect of brain injury (Lezak, 1978). Studies after periods of as long as 15 years have shown that one half to two thirds of persons with severe brain injury continue to manifest significant personality disturbances (Prigatano, 1991).

No discussion of personality and behavior change following TBI would be complete without addressing the premorbid factors, such as pre-injury emotional and psychosocial stability of the traumatically brain-injured patient. Importantly, there have been some suggestions from epidemiological literature that head injured patients may possess personal and social characteristics that predispose them toward injury (See Tsuang, Boor, & Fleming, 1985, for review). For example, personality characteristics such as low frustration tolerance, poor control of anger and hostility, and a tendency to engage in risk-taking behaviors have been described as more typical of individuals involved in motor vehicle accidents (Tsuang, Boor, & Fleming, 1985). Nevertheless, the contribution of these premorbid personality and behavior patterns to enduring post-injury changes has not been investigated in the literature.

In this regard, Prigatano (1987) suggested that the role of premorbid personality and behavior patterns may be relatively more important in cases of mild head injury than in moderate to severe injury where other factors such as neural tissue damage may play a larger role.

As noted above, although personality changes following TBI are frequently reported by patients, family members, and clinicians, such changes are generally difficult to define, conceptualize, and measure objectively. Jennett and Teasdale (1981) lamented in their influential medical text that personality change is "the most consistent feature of mental change after blunt head injury, but there is no way to measure it" (p.294).

At the most basic level, the problem of measurement lies in the paucity of suitable clinical instruments to quantify these characterological changes. Many researchers are critical of the approach of using existing clinical instruments that were initially developed for very different clinical populations (Gainotti, 1993; Sinchez-

Auclair, 1988). The main objection is that a clinical test developed to diagnose one disorder may provide an incorrect diagnosis when applied to a brain-injured population.

A prime example of this is the use of the Minnesota Multiphasic Personality Inventory (MMPI), an instrument developed for use with psychiatric populations (Greene, 1992). With regard to its use with brain-injured patients, Gainotti (1993) comments that there is “no reason to believe that emotional and personality changes resulting from damage to specific brain structures (or from lesions in general) must correspond to the psychiatric diagnostic criteria” (Gainotti, 1993, p.260). A second concern is raised by Prigatano (1987) who made the observation that there are a number of personality and behavior changes following which appear to have “a clear organic basis” (Prigatano, 1987, p. 14). That is, brain injury often produces neurological symptoms which, when accurately reported by survivors (e.g., inattention, parasthesia) results in elevated scaled scores on the MMPI. The normative and validation studies that form the basis of routine MMPI interpretation (i.e., in the context of possible psychiatric disorder) may not apply to head injured populations. Although the symptoms reported by brain injured patients may be accurate and informative, ‘traditional’ interpretation of their MMPI profiles may lead to a misdiagnosed psychiatric disorder when no psychosis is present and might indicate an inappropriate modality of treatment (e.g., antipsychotic medication).

In an attempt to address these issues, a number of researchers have begun to develop questionnaires specifically designed to assess the nature and extent of personality and behavioral change following TBI (Prigatano, 1987). An implicit assumption made by the developers of these clinical instruments is that many of these changes seen following TBI are, to a great extent, the result of neurological insult. As a result, the content of these questionnaires is based on current understanding of the neuropathology of traumatic brain injury.

<u>Neuropathology of traumatic brain injury</u>

Traumatic brain injury may be defined as "brain damage from a blow or other externally inflicted trauma to the head that results in significant impairment to the individual's physical, psychosocial, and/or cognitive abilities" (Parker, 1993, p.33). The majority of TBI's can be classified as "closed head injury" in which there is no penetration of the skull.

Research examining the neuropathology of closed head injury has found that two forces come into play when the brain is subjected to high velocity impact as in the case of a motor vehicle accident. First, injury results from rapid acceleration and deceleration of the head; initial damage may be at the point of impact ("coup"), which may result in contusion, hemorrhage, or laceration. With deceleration, there is a second area of impact opposite to the first ("contrecoup"). Importantly, due to the proximity of the frontal lobes and anterior temporal regions to the bony protrusions and cavities of the skull, focal lesions often occur to these areas, regardless of the site of impact (Gurdjian & Gurdjian, 1976; Levin et al., 1987; Ommaya & Gennarelli, 1974; Prigatano, 1991; Teasdale & Mendelow, 1984). Imaging studies have shown that the frontal region is the most common location of focal lesions in traumatic brain injury (Levin et al., 1987).

The second force results from the rotation of the brain that occurs during the high velocity impact and leading to diffuse axonal injury (DAI) or the shearing and stretching of axons throughout cortical and subcortical regions. Due to of the differential density of axonal connections within the cortex, axonal shearing is also commonly found in connections of the frontal lobes to other cortical and subcortical brain regions (Nevin, 1967).

Given the damage that so often occurs to the frontal lobes of the brain in TBI, an understanding of the cognitive and behavioral sequelae of TBI requires a knowledge of the neuropsychological functions thought to be subserved by this region of the brain.

Frontal lobe subsystems

There is growing evidence from both the human and animal literature for the existence of anatomically and functionally distinct frontal lobe subsystems (e.g., Cummings, 1993; Duffy, Campbell, & Salloway, 1994; Goldman-Rakic, P. S., 1996; Mega & Cummings, 1994). In a recent article, Cummings (1993) proposed a model fractionating the frontal region into three separate subsystems each of which is thought to subserve distinct functions (Eslinger et al, 1996; Stuss & Benson, 1984). Three subsystems that have been described are the dorsolateral prefrontal circuit, orbitofrontal circuit, and the medial/anterior cingulate circuit.

The dorsolateral cortex encompasses the largest area of the prefrontal cortex and has reciprocal connections with both posterior cortical association areas and many subcortical structures (Kolb & Whishaw, 1996; Cummings, 1995). As such, it plays a role in the integration of multimodal sensory inputs (Duffy & Campbell, 1994). Fuster (1997) has suggested that the dorsolateral cortex is involved in the temporal organization of information for the purposes of the initiation, sequencing, and execution of goal-directed behaviors. Thus, this region is thought to be involved in the generation of goal-directed behaviors, the modification of those behaviors in response to changes in the environment (set-shifting), and the maintenance of those behaviors in order to accomplish the goal (Malloy & Richardson, 1994). Most researchers characterize these functions as the traditional "executive" abilities. In fact, these particular cognitive abilities have been the object of the most extensive study of all the frontal lobe functions. Hence, the majority of neuropsychological tests that attempt to assess frontal lobe functioning have focused on these abilities (e.g., Heaton, 1981; Jones-Gotman, 1991; Reitan & Wilfson, 1995). The characteristic impairments associated with damage to the dorsolateral frontal region include poor integration and synthesis of information, disorganization in thinking and behavior, perseveration, cognitive inflexibility, and poor planning (Eslinger, et al, 1996; Stuss & Benson, 1984).

The second most commonly investigated area of the frontal region, the orbital frontal cortex, has extensive connections with limbic system structures and the diencephalon (Cummings, 1995). Many researchers have hypothesized that the orbital frontal cortex may play a specialized role in emotion-related learning and in mediating behavior in situations which require social judgements (Raleigh et al., 1996; Schore, 1994). Numerous clinical case studies have provided evidence that isolated damage to the orbitofrontal region is frequently associated with impairments in social and emotional judgements and, consequently, in disruptive changes in an individual's everyday social behavior (Damasio, 1994; Damasio, Tranel, & Damasio, 1991;

Hornak, Rolls, & Wade, 1996). The clinical literature in this area indicates that personality changes characterized by impaired inhibitory control, socially inappropriate behavior, and aggressiveness are frequently found in patients with orbitofrontal lesions (Cicerone & Tanenbaum, 1997; Malloy et al., 1993).

A third subsystem found in the frontal lobes, the medial subsystem, begins in the anterior cingulate cortex and projects to the nucleus accumbens. This circuit is thought to mediate many aspects of arousal and motivation. Medial frontal-subcortical circuit disorders feature apathy with reduced interest, motivation and engagement, and activity maintenance (Cummings, 1993). As noted below, the medial subsystem has only recently been described in the literature. Literature prior to 1985 exclusively referred to the dorsolateral and orbital frontal circuits and generally subserved the medial subsystem within the dorsolateral region.

Historical case studies of personality change associated with frontal lobe injury

Historically, the literature that has examined the issue of personality and behavior change following frontal lobe injury has followed the single case study format. There are numerous detailed case reports presented in neurological and medical literature stemming from the mid-nineteenth century.

In 1868, Harlow documented what is today considered the most widely recognized early case of personality change following frontal lobe injury. Harlow's articles from 1848 and 1868 described the case of Phineas Gage, a railway construction worker who sustained frontal lobe injury when an iron tamping bar was propelled by an explosion upward through his left jaw area, exiting through the midfrontal region. Gage survived the accident without basic neurologic disability or cognitive impairment. However, his personality underwent radical alteration. Prior to the brain injury, Gage had been described as a hard-working, sober, and reliable individual who, although not academically trained, possessed a "well-balanced mind and was very energetic and persistent in executing all his plans of operation" (Blumer & Benson, 1975, p.122). Harlow described Gage's *post-injury* personality as follows:

> "The equilibrium or balance, so to speak, between his intellectual faculties and animal propensities seems to have been destroyed. He is fitful, irreverent, indulging at times in the grossest profanity, manifesting but little deference for his fellows, impatient of restraint or advice when it conflicts with his desires, at times pertinaciously obstinate, yet capricious and vacillating, devising many plans of operation, which are no sooner arranged than they are abandoned in turn for others appearing more feasible."

In a recent study, Damasio et al.(1994) took measurements from the skull of Phinea Gage and used neuroimaging techniques to determine the probable location of the lesion. Their findings suggest that the injury Gage sustained led to damage in the anterior half of the orbital frontal cortex in both hemispheres. There was no damage outside of the frontal regions.

Several decades later after Harlow's case study on Gage was published, similar personality and behavior changes in patients with lesions of the orbital frontal regions were described in case reports documented by Jastrowitz (1888), Oppenheim (1890) , and Welt (1888).

Kliest (1930, 1934) attempted to relate localized brain lesions to behavior and personality change and is credited with first fully outlining the characteristic features of what would later be termed distinct "frontal syndromes". He confirmed Welt's thesis that orbital frontal lesions often lead to specific personality changes (e.g., disinhibition, aggression, irritability). He further noted that lesions of the frontal convexity, that is, dorsolateral regions, were often associated with apathy or lack of mental and physical initiative. Case studies and review papers by Brickner (1934; 1936) and Benton (Ackerly & Benton, 1948) soon followed and further documented consistent behavior and personality changes associated with lesions of specific regions of the frontal lobes.

Contemporary investigations of personality change following frontal lobe injury

Contemporary interest in frontal personality syndromes can be traced to an influential review published by Blumer and Benson in 1975. Following Kliest and others, these authors described two significantly different personality alterations that appeared to correlate with structural damage to specific regions within the frontal lobes. They coined the term *pseudo-depressed* personality type to describe those individuals with lesions in the prefrontal convexity or dorsolateral regions of the frontal lobe. According to Blumer and Benson, *pseudo-depressed* patients exhibited personality changes characterized by apathy, slowness and lethargy, indifference, and a lack of drive or initiative. The second frontal personality syndrome described by Blumer and Benson was termed the *pseudo-psychopathic* personality type. Individuals with post-injury *pseudo-psychopathic* personality were characterized as "coarse, irritable, facetious, hyperkinetic or promiscuous; they often lack social graces and may, on impulse, commit anti-social acts" (p. 158). They noted that, based on their review of the literature, this latter personality syndrome frequently followed lesions of the orbital frontal regions. Despite this advance, Blumer and Benson did not provide any guidelines with regard to categorizing or quantifying the personality changes associated with both subtypes.

In two influential review papers, Stuss and Benson (1983; 1984) summarized the extant literature on cognitive, behavioral, and personality changes following frontal lobe damage. After reviewing the existing case studies and the few group studies examining the issue of personality change, Stuss and Benson (1983) noted that no studies to date had operationalized the criteria for formally assessing personality alteration following frontal injury. They concluded that "there is an obvious need for *quantified* investigations of frontal personality disturbances" (p. 448).

More recently, Stuss & Gow (1992) reviewed the evidence for what they termed "frontal dysfunction" following traumatic brain injury. In discussing areas for further research, they concluded that important topics included the "nature of personality change; the presence and interrelationship of reactionary, neuropsychologically mediated and characterological personality disturbances…" (p.279).

Eslinger and Damasio (1985) provided the seminal description of patient EVR. who underwent resection of an orbitofrontal meningioma involving the ventromesial frontal cortices bilaterally. Despite intact and even above average or superior intelligence, memory, and executive functioning as assessed on standardized tests; following surgery, EVR's personality and behavioral functioning was radically changed for the worse.

Prior to his neurosurgery, EVR was a financial officer with a small company and a respected member of his community. He was married and the father of two children. His family members considered him a role model and a natural leader. After the operation, EVR lost his job, went bankrupt, was divorced by his wife, and moved in with his parents. He subsequently married a prostitute and was divorced again within two years. Post-operatively, EVR was often unable to make simple decisions about what toothpaste to buy, what restaurant to go to, or what to wear. It was reported that he would instead become stuck making endless comparisons and contrasts, often making no decision at all or a purely random one.

More recently, Cicerone and Tanenbaum (1997) provided a detailed case study of a patient SAL, a 38-year old woman who sustained a tramatic brain injury when she was struck by a motor vehicle. An MRI obtained seven months post-injury demonstrated orbitomedial frontal lobe damage in the left hemisphere. Extensive neuropsychological assessment demonstrated that SAL showed good overall cognitive recovery but lasting and significant disturbances in emotional self-regulation and social cognition, two domains thought to be subserved by the orbital frontal subsystem.

Many of these case studies have provided a rich and detailed description of personality and behavior change following frontal lobe injury. However, case studies as such cannot lead to generalization of findings in any broad manner. It would be more desirable to have group studies examining the nature and extent of frontally-based behavior and personality change. Such studies would allow us to have greater confidence in the inferences made with regard to lesion site and behavioral correlates.

Group studies investigating personality change following frontal lobe injury

A few studies have examined behavior and personality changes in clinical groups with compromised frontal lobe functioning including Huntington's disease (Burns, Folstein, Brandt, and Folstein, 1990), and multiple sclerosis (Rao, Huber, and Bornstein, 1992).

Kertesz, Davidson, and Fox (1997) developed the Frontal Behavior Inventory (FBI), a 24-item questionnaire constructed to target the most specific behaviors or personality changes associated with frontal lobe dementia (FLD). The core diagnostic features of FLD include both mainly negative behaviors (e.g., apathy, aspontaneity, emotional indifference) and positive behaviors (i.e., disinhibition, jocularity, social inappropriateness, hypersexuality). The questionnaire was administered to primary care-givers. Kertesz et al. (1997) found that FLD patient ratings on the FBI were significantly higher compared with a control group of Alzheimer's disease (AD) matched for stage and severity to FLD and a group of patients with pseudo-/depressive dementia (DD). The authors concluded that the FBI is a useful diagnostic instrument that operationalizes the behavioral criteria of FLD and that may be useful in exploring behavioral and personality changes in other diagnostic groups including head injury. Unfortunately, Kertesz et al. (1997) did not conduct any in-depth analyses on the FBI questionnaire . For example, it would be interesting to know whether individual FBI items clustered together in distinct factors corresponding to "orbital" and "dorsolateral" subtypes described elsewhere. In addition, it would be interesting to know which items or subgroup of items best differentiated among the three clinical groups.

One attempt to quantify personality changes associated with damage to the frontal lobes in a population of traumatically brain-injured patients can be found in a study by Walker (1991). Walker (1991) examined whether distinct patterns of neuropsychological functioning were associated with frontal personality subtypes in a group of patients with traumatic brain injury. Using Blumer and Benson's (1975) general classification, Walker (1991) developed a 10-item questionnaire that assessed personality and behavior characteristics associated with the two frontal personality syndromes. The questionnaire consisted of five items were based on features of the *pseudo-depressed* subtype (e.g., apathy, shows little interest or concern) and five items were related to the *pseudo-psychopathic* subtype (e.g., disinhibited, acts impulsively).

Questionnaires were completed by patients' primary caseworkers. For each item, raters were asked to indicate whether the behavior described was true or false with regard to the patient. Patients who were rated affirmatively on at least three of the *p-dep* items and negatively on at least four of the *p-pd* items were classified within the "pseudo-depressed" group. The converse was true for the classification of the "pseudo-psychopathic" group. A negative answer to all but two even and/or two odd questions resulted in assignment to the group showing no evidence of frontal behavior disorder (*n-fbd*). Based on this classification, all patients were assigned to one of these three groups with 10 subjects per group.

Walker (1991) used a battery of 13 tests that were representative of a broad range of cognitive abilities (e.g., attention, memory, verbal and visual spatial ability) including tests with demonstrated sensitivity to cognitive deficits associated with frontal lobe damage. Overall, Walker (1991) found that these two frontal personality subtypes did not demonstrate unique cognitive profiles. The only significant finding was that the pseudo-depressed subgroup performed worse than the other two groups on tests of verbal and nonverbal fluency (Controlled Oral Word Association and Five Point Test, respectively) and a test of visual learning (Benton Visual Retention Test). Walker (1991) suggested that impairments in fluency and nonverbal new learning may be characteristic of pseudodepressed patients, but not of pseudopsychopathic patients or patients without frontal behavior disorders.

Walker (1991) also found that measures of frontal lobe functioning (i.e., WCST, Stroop) did not reliably differentiate between the frontal personality subtypes. In addition, those groups with frontal behavior disorder (*p-dep* and *p-pd* groups) did not demonstrate a pattern of significantly different performance when compared to those patients without frontal behavior disorders (*n-fbd* group) on these traditional tests of frontal lobe functioning. Based on these findings, Walker (1991) suggested that, while tests of frontal abilities have proven useful in identifying frontal lobe injury, they do not differentiate between those with and without frontally-based personality syndromes.

Walker's (1991) study represents one of the few attempts in the literature to examine, in a quantitative manner, whether distinct frontal lobe personality syndromes can be found in individuals with traumatic brain injury. It is also unique in its attempt to determine whether specific neuropsychological profiles are associated with the different syndromes.

The small sample size in Walker's (1991) in conjunction with the large number of analyses that were conducted limited the generalizability of the findings from this study. In addition, the classification of subjects into the different frontal subgroups based on the questionnaire can be questioned. For example, Walker (1991) notes that there is no research supporting the validity or reliability of the questionnaire used in the study. Despite Walker's finding of two relatively distinct frontal subtypes within her sample, the notion that discrete behavioral syndromes would typically be found in individuals with traumatic brain injury is unlikely. Indeed, given the diffuse damage that often occurs within the frontal region, it is much more likely that the frontally-based personality and behavior change seen in this population would reflect behavior and personality changes consistent with each of the frontal lobe subsystems, with perhaps one subtype predominating (Stuss & Benson, 1984).

Dywan and Segalowitz (1996) developed the *Brock Adaptive Functioning Questionnaire* (BAFQ), a questionnaire designed to measure psychosocial and adaptive functioning, and intended specifically for use with traumatic brain injury populations. Dywan and Segalowitz (1996) argue that any attempts to assess behavior and personality change in individuals with traumatic brain injury must begin with consideration of the effects of frontal lobe injury that typically occurs in this population. Consequently, the construction of the BAFQ was based on current theoretical models of frontally-based processes.

In an initial study, Dywan and Segalowitz (1996) administered a 5-subscale version[1] of *BAFQ* to 13 adults who had sustained moderate to severe brain injury. A family member of each TBI participant was also asked to complete the questionnaire.

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[1] The five subscales were Planning, Initiation, Attention/Memory, Arousal, Social Monitoring (Dywan & Segalowitz, 1996).

All TBI participants were administered a battery of neuropsychological tests assessing a variety of cognitive abilities. In addition, an electrophysiological measurement, specifically the contingent negative variation (CNV), was also elicited and measured. The CNV is a frontally generated, event-related potential that is thought to be generated within dorsolateral prefrontal cortex (Fuster, 1997).

The authors reported that two distinct clusters emerged from the pattern of correlations among the *family* ratings on the BAFQ subscales. The pattern of correlations among family responses were interpreted to reflect two separate areas of abilities related to the *dorsolateral* and *orbital* frontal subsystems, respectively.

Two significant relationships were found between *BAFQ* subscales and specific psychometric measures. First, family ratings on the *Planning* and *Initiation* subscales were highly correlated with perseverative errors on the WCST. The authors note that this finding is consistent with other research linking WCST performance to dorsolateral prefrontal areas. Family ratings on the same subscales were also strongly correlated with one of the phases of the electrophysiological measure, the CNV. However, no other subscale-test performance correlations proved to be significant. The authors argued that part of the difficulty in finding significant correlations lies in the fact that there are few neuropsychological measures that have demonstrated sensitivity and specificity to frontal lobe subsystem dysfuction.

In a second study, Dywan, Roden, & Murphy (1995) administered a revised 12-scale version of the *BAFQ* to 199 high school students. Subjects' self-ratings were submitted to a confirmatory factor analysis which yielded a two-factor solution. Again, the two factors were interpreted by the authors as representing a dorsolateral and orbital factor.

Dywan et al. (1995) found significant correlations between student's grade point average (GPA) and both the *dorsolateral* and *orbital* factor scores derived from the BAFQ. Dywan et al. (1995) also found that a history of previous head injury (according to self-report) was a significant predictor of the students' scores on orbitofrontal factor.

The findings from both studies are important in that they have demonstrated a significant relationship between psychometric and academic indices and questionnaire measures of personality and behavior change linked to frontal lobe dysfunction. However, a number of factors limit the generalizability of the results. First, in the initial validation study, the sample size was small (n=13). More importantly, however, the authors' interpretation of the factor loadings that emerged from their analysis can be questioned. Although some of the functions assessed by the different subscales appear to be related to different frontal subsystems (e.g., *Dyscontrol* on the orbital factor; *Planning* on the dorsolateral factor), it is not clear that the loading of *all* the subscales clearly map onto the theoretical distinctions made between these two frontal subsystems.

A second limitation of the BAFQ studies lies in the psychometric measures chosen to evaluate functions associated with frontal lobe subsystems. Although evoked potentials of the CNV is clearly a valid and well-documented method for measuring frontal activation, the other psychometric measures chosen by the authors are not well validated as being sensitive to frontal lobe dysfunction.

A final limitation of the *BAFQ* is that it attempts to evaluate different behaviors that are associated with frontal lobe subsystems in an indirect manner. It is unclear whether the measure is intended to be used to examine frontal lobe personality and behavior change specifically or whether it is to be used as a broad measure of overall adaptive functioning.

Given our current knowledge of the behavioral sequalea of damage to different subsystems of the frontal lobes, a more effective method for evaluating the personality and behavior changes associated with such injuries would be to begin by developing separate subscales associated with these separate domains of frontal lobe functioning.

Rolls, Hornak, Wade, and McGrath (1994) examined the relationship between performance on computer-administered learning tasks that require cognitive functions associated with the orbitofrontal cortex and questionnaire measures of behaviors associated with frontal lobe damage. Patients with circumscribed orbitofrontal lesions and brain-injured controls with damage outside of this region. The experimental tasks designed by Rolls et al. (1994) were based on the standard Go/NoGo paradigm. Studies examining orbital frontal functioning in different clinical populations have provided evidence for the sensitivity of such tasks to dysfunction in this cortical region (Drewe, 1975; Leimkuhler & Mesulam, 1985; Malloy, Rasmussen, Braden, & Haier, 1989). The behavioral questionnaire developed by the authors examined behaviors commonly associated with damage to the frontal region (e.g., disinhibition or social inappropriateness, inflexibility, flat affect). Rolls et al. (1994) found that patients with orbital frontal damage performed significantly worse on the Go/NoGo tasks compared to brain-injured controls and were also rated as having significantly more behavioral problems than brain-injured controls on the questionnaire measure. This relationship was independent of measures of general intelligence and memory ability.

When data from both patient groups were analyzed together, significant correlations were found between overall scores on the behavioral questionnaire and the percentage of commission errors on both the Go/NoGo tasks.

The results regarding impaired performance on these tasks in the patients with orbital frontal lesions is consistent with previous studies examining performance of such patients on tasks requiring response inhibition (Malloy & Richardson, 1994). However, this is the first study to relate performance on such tasks to patient's everyday social and emotional functioning. Unfortunately, the questionnaire developed by the authors did not specifically target symptoms that have traditionally been associated with the orbital frontal subsystem.

In a recent study, Sarazin et al. (1998) examined correlations among neuropsychological test performance, neuroimaging data (i.e, magnetic resonance imaging (MRI) and regional cerebral glucose metabolism (rCMRGlu), and behavioral functioning as indexed by questionnaire in a group of 13 patients with lesions of the prefrontal cortex. Patients were a heterogenous group compromised of frontotemporal dementia, vascular lesion, and traumatic brain injury. Six of these 13 patients presented with focal frontal lobe lesion on MRI.

All patients were administered a battery of neuropsychological tests of executive or frontal lobe functioning including Wisconsin Card Sort, Stroop, Trail-Making, and Go-NoGo tasks. In addition, disturbances in social skills and daily life were assessed in a semistructured interview format using a scale developed by Lhermitte et al (1986). A second questionnaire on "disorganization in daily life" investigated three different components of action in daily activities (e.g., planning activation, execution, and control). Collateral raters were either family members or clinical staff.

Executive-function test performance was significantly correlated with rCMRGlu in the dorsolateral prefrontal cortex and medial prefrontal cortices. These correlations excluded rCMRGlu in the orbital frontal cortex.

In contrast, behavior rating scores on the questionnaire developed by Lhermitte et al (1986) and ratings on their own "disorganization in daily life" questionnaire were significantly correlated with rCMRGlu in the orbitofrontal cortex and in the frontopolar regions (Brodmann's area 10).

Sarazin et. al (1998) concluded that these findings led support to the notion of distinct functional subsystems within the frontal region. However, they argued that the model proposed by Cummings (1993) was only partially supported by their findings in that they did not find any specific correlations between behavioral disturbances and metabolism in the medial frontal regions as predicted by this anatomofunctional model. The authors noted that the finding of significant relationship between ratings on the "disorganization in daily life" questionnaire and orbitofrontal and not with dorsolateral metabolic activity lends support to oft-cited dissociation between planning abilities assessed under test conditions, which are often strongly related to cognitive functions and working memory, and planning abilities in daily life, which may be more strongly related to affective disturbances and social cognition (which, in models proposed by Damasio et al. (1991) and others, are subserved by the orbitofrontal cortex).

Importantly, they note that, the relative independence of these two functional subsystems (dorsolateral and orbitofrontal) may account for clinically observed discrepancies between performance on tests of executive functioning and patients' level of independent functioning in daily life, "wherein affective and social interactions may be determinant, particularly for decision-making" (pp. 147).

Unfortunately, the questionnaire used by Sarazin et al. (1999) again fails to distinguish between different frontal lobe personality/behavioral syndromes.

Tate (1999) administered the Current Behavior Scale (CBS; Elsass and Kinsella, 1989) to close family members of 30 patients with severe traumatic brain injury at admission to hospital and six months post trauma. The CBS is a 25-item questionnaire designed specifically to assess behavioral changes following TBI. The 25 items are bipolar adjectives that are rated on a 7-point scale. A previous factor analytic study (Kinsella, Packer, and Olver, 1991) had identified two unique factors: Loss of Emotional Control (LEC) and Loss of Motivation (LM). LEC items included impulsivity, aggression, restnessness while LM items included lacking energy, disinterested, and lacking initiation.

In the Tate (1999) study, all TBI patients and 30 normal control participants were also assessed with a battery of neuropsychological measures including tests of executive functioning (e.g., Word Fluency, Design Fluency (Jones-Gotman and Milner, 1977), Austin Maze (Walsh, 1991), and the WCST). An important unique aspect to this study was the coding of Rule-Breaking Errors on all Fluency tests (e.g., not beginning with specified letter on Word Fluency, repetitions, core words with different suffixes; Design Fluency: nameable designs, repetitions, Austin Maze:

backtracking, diagonal moves).

Tate (1999) found statistically significant differences between collateral pre and post-injury ratings on both the emotional and motivational factors. TBI patients also demonstrated significantly poorer performance on all tests of executive function when compared to normal controls.

Tate (1999) also found that a significant correlation between Rule-Breaking Errors on Fluency tests and post-injury LEC ratings supporting the hypothesis that Rule-Breaking on Fluency tests have clinical utility in documenting the types of everyday difficulties in behavioral dyscontrol observed by relatives. Tate (1999) also reported a trend for those TBI patients with frontal lesions documented by computerized tomography (CT) to make more rule-breaking errors compared to TBI patients without frontal lesions.

This study by Tate (1999) provides evidence for the general clinical utility of the CBS in traumatically brain-injured populations. However, from a research perspective, the factor structure of the scale does not allow one to examine the relationship between personality change as it relates to frontal lobe subsystems.

Recently, Grace, Malloy, & Stout (1999) have developed the Frontal Lobe Personality Scale (FLOPS), a questionnaire specifically designed to assess behavioral and personality changes associated with damage to the frontal lobes. The FLOPS consists of three separate subscales that reflect current clinical-anatomical models of frontal lobe subsystem functioning (Cummings, 1995; Duffy & Campbell, 1994). The items for each of the subscales were derived using a face validity approach. After a comprehensive review of the literature regarding the behavior change following frontal lobe damage, a list of descriptors of these behaviors was generated, and items for behavior rating were developed. Items were then sorted by the authors according to their face-valid relationship with each of the three frontal behavioral syndromes discussed above. Content validity of this sorting method was evaluated by having an independent rater perform a Q-sort targeting of the three frontal syndromes. There was a high rate of agreement between the original classification of scale items and the expert's independent sorting of items (Kappa=.77, $p < .001$).

The "Executive dysfunction" subscale is composed of items that assess the cognitive abilities associated with the dorsolateral frontal cortex (e.g., planning, flexibility). The "Disinhibition" subscale assesses the presence of behaviors that have been associated with damage to the orbital frontal cortex (e.g., behavioral disinhibition, social inappropriateness, emotional dysregulation). Finally, the "Apathy" subscale assesses behaviors that have been associated with the medial frontal cortex (e.g., apathy, low arousal, akinesia).

Grace et. al (1999) validated the FLOPS self and family ratings using 15 patients with focal frontal lesions (FL) with various etiologies (e.g., focal stroke, meningioma, aneurysm). Frontal lesion site was confirmed by brain imaging in all cases. The study also included patients with unipolar depression (UD; $n = 24$), bipolar depression (BP; $n = 21$), and normal controls (NC; $n = 27$). All subjects were matched with the frontal lesion cases for age and level of education. Retrospective pre-injury ratings were collected for the frontal lesion group.

A high degree of internal consistency Cronbach's alpha (Cronbach, 1951) was found across all three subscales, for both pre and post-lesion ratings on the family form (Range:.81-.94). The self-ratings of patients on the FLOPS also demonstrated good reliability (Range: .78-.93).

Frontal patients and their families rated their post-lesion behavior as significantly more abnormal relative to their pre-lesion behavior across all FLOPS subscales.

Patient and family ratings of frontal patients on the FLOPS were significantly higher (that is, more behavior-disordered) than normal control participants across all three subscales. Ratings of normal controls showed very low mean scores across all scales indicating that the behaviors described by the FLOPS are rarely observed in the normal population.

The authors next examined to what extent the FLOPS demonstrates some degree of specificity and is not just tapping abnormal behavior, per se. The results from the comparison of frontal patients and psychiatric research participants (unipolar and bipolar depression) supported this.

On the family ratings, frontal patients differed significantly from both psychiatric groups (unipolar and bipolar depressed) on the *Apathy* (Medial) and *Executive* (Dorsolateral) subscales and the FLOPS total scale score, while the two psychiatric groups did not differ from each other across these scales. Groupwise comparisons for the *Disinhibition* (Orbital) indicated a significant difference between frontal and unipolar patients.

Results for the self-ratings showed that frontal patients rated themselves as significantly more impaired on the FLOPS Total scale, and the *Apathy* (Medial) scale compared to both psychiatric patient groups who did not differ from each other.

In summary, this study indicated that frontal behavioral syndromes can be reliably rated by patients and family members. The FLOPS was able to quantify a significant change in behavior from pre- to post-lesion in frontal subjects. Second, the FLOPS was able to detect the expected differences between the abnormal behavior in patients with frontal lobe damage relative to normal behavior in healthy controls. Third, the FLOPS was able to distinguish between the behavior of frontal lobe patients and behavior in psychiatric groups.

The FLOPS has also been used to examine personality and behavioral features associated with prototypical "cortical" dementia (probable Dementia of the Alzheimer type; PDAT) and "subcortical" dementia (Huntington's disease; HD). Paulsen et al. (1996) administered the FLOPS to caregivers of patients with either PDAT or HD. All patients were given administered a extensive neuropsychological assessment battery.

The authors used t-tests to compare HD and PDAT groups across the three subscales. Only the *Apathy* subscale differed significantly between the groups with HD patients being rated as showing greater adynamia.

A series of stepwise multiple regressions were performed on each FLOPS subscale using the different neuropsychological measures. A number of significant relationships were found between neuropsychological performance variables and family ratings on the FLOPS.

First, patient's scores on the Verbal Fluency test were significantly related to family ratings on the Apathy subscale. The authors suggest that this scale may be assessing the ability to begin or initiate behavior. Thus, patients rated as lacking in motivation or spontaneity may also have difficulty initiating the necessary search and retrieval strategies required by the Verbal Fluency test.

Second, patients' Recognition Memory Response Bias on the CVLT, a measure of response intrusion, and intrusions on the Verbal Fluency test were significant contributors to the regression equation for the FLOPS Disinhibition scale, accounting for 45% of the variance ($p<.01$). The authors suggested that disinhibited response styles may account for performance on these measures, leading to a greater proportion of intrusions and inappropriate responses.

Total recall on CVLT, recognition response bias, digit span, and Trails-B contributed to the regression equation for the FLOPS executive function subscale, accounting for 57% of the variance ($p < .01$). According to the authors, these measures of list learning, attention, and cognitive flexibility have traditionally been associated with dorsolateral prefrontal damage (see Stuss & Benson, 1984).

Discriminant function analyses using the Apathy (Medial) and Executive Function (Dorsolateral) subscales accurately classified over 92% of the DAT patients and nearly 77% of the HD patients. The authors note that these results are consistent with the discriminative utility of traditional neuropsychological test instruments.

Thus, this review of the existing literature on the FLOPS suggests that it appears to evaluate different behaviors that associated with frontal lobe subsystems in a more *direct* manner than previous questionnaire measures discussed. This questionnaire has yet to be used with individuals who have sustained a traumatic brain injury. In the present study, a more detailed evaluation of frontally-based behavioral and personality syndromes often associated with TBI will be made using the FLOPS questionnaire.

Neuropsychological correlates of behavior/personality change following TBI

One limitation of previous studies examining the relationship between neuropsychological performance and personality and behavior changes following TBI lies in the neuropsychological measures commonly used. In their study of traumatic brain-injured patients, Dywan & Segalowitz (1996) found that most traditional measures of "executive functioning" were poorly correlated with the different domains of adaptive functioning as assessed by the Brock Adaptive Functioning Questionnaire (BAFQ). The authors argue that part of the reason for this lack of relationship lies in the limitations of our current psychometric measures. In particular, they note that the highly structured and constrained nature of traditional measures of "executive functioning" limit the degree to which an individual is actually required to demonstrate skills and abilities related to this construct. The development of measures of "executive function" that simulate everyday problem-solving and planning activities may bridge the gap between neuropsychological performance and measures of adaptive functioning in persons with TBI (Wilson et al, 1996).

However, an alternative account for the lack of relationship may relate to the measures of executive functioning chosen by researchers in this area. As noted earlier, recent literature examining traditional measures of executive functioning (e.g., WCST) has noted that damage to various cortical and subcortical regions can lead to impaired performance. Stronger relationships between neuropsychological test performance and everyday abilities may be found with the use of neuropsychological tests that have been theoretically and experimentally linked to brain regions involved in executive functioning, namely, the frontal lobes. Accordingly, the following sections will describe four neuropsychological tests whose construct validity has been empirically validated with respect to specific anatomical regions of the frontal lobes. It is important to note that, although these studies provide some evidence relating a given cognitive function with a given neuro-anatomical area, this evidence is not put forward here to assert that, for example, the 'role of neurological area A is cognitive function X'. Rather, these studies are presented to provide some indications of the importance of given neuro-anatomical regions to the adequate performance of certain cognitive abilities.

Self-Ordered Pointing Task

The self-ordered pointing task (SOPT; Petrides & Milner, 1982) is a "working memory" task that has shown promise as being sensitive to lesions of the dorsolateral prefrontal region. In this task, subjects are presented with a specified number of designs on an equal number of pages. The same designs are found on all pages, however, they are placed in different positions on each page. Subjects are instructed to turn the pages and point to a different design each time. Petrides and Milner (1982) have argued that, for this task, subjects must plan their subsequent responses and at the same time keep track of those responses they have previously made. Thus, considerable demands are made on working memory and planning abilities, two cognitive skills that are thought to be subserved by the dorsolateral prefrontal cortex.

Recently studies have linked performance on the SOPT with functioning of the dorsolateral prefrontal cortex in both humans and nonhuman primate populations (Petrides, 1995; Petrides, 1996). A number of neuroimaging studies have consistently normal controls on the FAS Verbal Fluency task (Spreen & Benton, 1969; 1977). For this task, subjects must say aloud as many words as they can that begin with a given letter (i.e., F, A, S) within a one minute period. Crowe (1992) found a nonsignificant trend toward lower levels of production in the mesial group compared to all other groups. He noted that the small sample size and the fact that many patients had mixed pathologies may have reduced his ability to find significant differences among the groups.

Boller et al. (1995) measured the regional cerebral glucose metabolism (rCMRGlu) with positron emission tomography in 17 alcoholic patients. Patients were selected according to DSM-III-R criteria and tested after 1-3 weeks of alcohol withdrawal. Mean duration of alcoholism was 12 years. All patients were given the Stroop and Verbal Fluency tests. The degree of relative medial prefrontal hypometabolism was significantly correlated with verbal fluency performance ($r = .63$, $p = 0.02$) and, to a lesser extent, with Stroop interference time ($r = -.51$, $p = 0.04$).

Finally, it should be noted that, in the above-mentioned study by Paulsen, et al. (1996) examining FLOPS ratings and neuropsychological test performance in dementia patients, Verbal Fluency was the only measure to enter the regression equation for the Apathy/Mesial Frontal scale.

In conclusion, there does appear to be some evidence to support the notion that the measure that has shown the most promise in discriminating the deficits associated within the mesial frontal is the Verbal Fluency test.

<u>TBI and Awareness of Deficits</u>

There is a substantial body of literature that has documented impairments in awareness of cognitive and behavioral deficits in individuals who have sustained a traumatic brain injury (Prigatano, Altman, & O'Brien, 1990). In addition, many clinical reports have found that lack of awareness of deficits is often present in patients with isolated damage to the frontal lobes (Stuss, 1991). However, the question of whether lack of awareness of deficits is related to impaired frontal lobe functioning in TBI individuals has not been examined.

Awareness of deficit and how it is best evaluated in clinical populations is a large topic and beyond the scope of the present study. Nevertheless, given that both self and collateral ratings will be collected, the opportunity for examining the issue presents itself.

The relationship between TBI patients' lack of insight and specific cognitive deficits has only been examined in a few studies to date (e.g., McKinlay & Brooks, 1984). These authors found no relationship between patients' tendency to underreport symptoms and general measures of verbal and nonverbal intelligence, recall, fluency and comprehension. However, these authors did not include measures of executive functioning in their assessment battery. Thus, the relationship between frontal functioning and awareness of deficit in adaptive functioning has yet to be examined in the TBI population.

Based on current research there is some reason to believe that the orbital frontal region of the frontal lobes may be implicated in awareness of deficit. Unawareness of deficit may be secondary to impairments in cognitive functions subscribed to the orbitofrontal cortex such as monitoring of social behavior (Cicerone & Tanenbaum, 1997) and the skills of critical self-appraisal (Malloy et al., 1993).

In the proposed study, both self-report and collateral versions of the FLOPS are completed allowing for comparisons to be made between self and collateral ratings. This comparison allows for an estimate of the TBI individual's level of insight and awareness with regard to their adaptive functioning.

The Present Study

General:

1. Can specific measures of frontal functioning enable us to predict specific areas of personality and behavior changes indexed by the FLOPS that relate to the dorsolateral, orbital, and medial frontal subsystems of the brain, respectively?
2. Will the findings of reduced awareness of deficits in individuals who have sustained a traumatic brain injury be replicated?
3. Are impairments in self-awareness of deficits related to performance on specific tests of executive abilities thought to be subserved by the frontal lobes?

The following specific hypotheses will be tested:

1. Subjects' SOPT scores are predicted to show significant correlation with ratings on the dorsolateral (DOR) subscale but not the orbital (ORB) or medial (MED) subscales of the FLOPS.
2. Subjects' performance on the both the GO/NOGO and Stroop tasks are hypothesized to be predictive of scores on the orbital (ORB) but not the other two FLOPS subscales.
3. Subjects' scores on the Word Fluency test are predicted to be significantly related

to ratings on the MED subscale of the FLOPS but not the other two FLOPS subscales.

These predictions are made for both the head-injured participants' and collaterals' ratings on the FLOPS.

The second stage of analysis will examine the ability of the neuropsychological tests to differentially predict brain-injured individuals' subscale scores on the FLOPS over and above measures of general conceptual ability (i.e., WAIS-R). Subjects' scores on the WAIS-R, GO/NOGO, SOPT, and VERFLU will be entered in a hierarchical regression with each FLOPS subscale (i.e., DORS, ORB, MES, FLOP-TOT) serving as the criterion measure on four separate analyses. For all regression analyses, WAIS-R FSIQ will be entered at Step 1.

4. It is hypothesized that after controlling for general conceptual ability (i.e. WAIS-R Screener), the aforementioned subscale-test relationships will remain significant.

These analyses will be conducted with the head-injured participants' and collaterals' ratings on the FLOPS.

<u>Analyses Related To Awareness of Deficit</u>

Head-injured subjects' performance on the neuropsychological measures are predicted to be significantly related to the degree of discrepancies between self-report and collateral reports on the FLOPS. Regression analyses will be conducted where performance scores on the neuropsychological measures will be used as predictors and self/collateral discrepancy scores will serve as the criterion. Separate regression analyses will be conducted for those subscales on which there are self-other discrepancies in the hypothesized direction.

5. It was hypothesized that after controlling for general conceptual ability (i.e., WAIS-R Screener), the orbitofrontal scores (i.e. reversal Go/No Go, Stroop) would be stronger predictors of the FLOPS TOTAL self-other discrepancy scores than the dorsolateral predictor (SOPT) or medial predictor (MES). To test this hypothesis, the aforementioned variables were entered into a multiple regression analysis such that the predictive value of the individual variables could be examined.

Method

Participants

A total of forty-five adults who had sustained traumatic brain injury were recruited from three locations: twenty-two from the Skeleem Recovery Centre (in-patient rehabilitation program), Cobble Hill, British Columbia; sixteen from the North Alberta Head Injury Association, Edmonton, Alberta (community living); and five from the Ponoka General Hospital (in-patient program). In addition, two participants were recruited from the Victoria, British Columbia community.

Human subjects ethics approval was obtained from the University of Victoria, from the respective programs, and informed consent was obtained from each participant. Participation in the study required approximately two hours of time for which each participant was paid fifteen dollars.

Setting & Apparatus

The study took place in a quiet experimental room with the experimenter and participant seated facing each other across a table. Equipment used consisted of WAIS-R subtests comprising the Vocabulary plus Block Design short-form, FLOPS self and other rating scales, Go/No Go test, Stroop (Victoria) test, and the Self-ordered pointing task (SOPT). Data collection was performed by either Nicholas Bogod, Douglas Barrett, or Dr. Peter Wass. Individuals very familiar with the participants such as family members, therapists, or caregivers completed the FLOPS "other" ratings.

Measures

Frontal Lobe Personality Scale (FLOPS)

The Frontal Lobe Personality Scale is a 46-item questionnaire that assesses personality and behavioral change thought to be related to damage to frontal brain regions. It is comprised of three subscales that reflect current understanding of frontal lobe subsystems: a)a dysexecutive subscale related to dorsolateral damage, b) disinhibition subscale related to orbital frontal damage, and c) apathy subscale related to mesial/anterior cingulate pathway damage. Ratings across the different personality and behavioral dimensions are made on a 5-point Likert scale ranging from "Almost Never" (1) to "Almost Always" (5). A copy of the FLOPS questionnaire is shown in Appendix 1.

Executive Function Measures

Go / No Go task

This is a computer administrated visual Go/No Go paradigm modeled after

LaPierre, Braun and Hodgins (1995) that is designed to measure the participant's capacity to inhibit responses. The task is divided into two trial blocks. The first block is composed of 60 trials in which the participant is presented with white squares (2 x 2cm) in pseudo-random screen positions at one second intervals. The participant is required to respond to each presentation by pressing the spacebar as quickly as possible, causing the square to disappear. This block is included in order to develop a response set to squares and is not scored. The second trial block consists of 150 trials, divided into 3 blocks of 50 trials each. In the first 50 trials, the participant is required to respond to white crosses (2 x 2cm) while withholding responses to white squares (2 x 2cm). The second 50 trials require response to squares while withholding responses to crosses. The response requirements then reverse again for the final 50 trials. Scoring is based on totaling commission errors (incorrectly responding to a "no go" cue) and omission errors (not responding to a "go" cue) over the three 50 trial blocks, and on choice reaction time.

Victoria Stroop (Regard, 1991)

A standardized measure of verbal inhibitory capacity comprising 3 - 21.5 x 14cm pages each containing 6 rows of 4 items. The first card contains colored dots (blue, red, yellow and green) which the participant is asked to read out loud (left-to-right) as quickly as possible. The second card contains common words ("when", "hard", "over" and "and") printed in the colors of the dots in the first trial. The participant is required to name the colors the words are printed in as quickly as possible while ignoring the verbal content. The third card is similar to the second except that the words are the names of the print colors, with the print color never matching the color word. The participant is required to disregard the verbal content and respond with the color the word is printed in (e.g. responding "green" to the word "blue" printed in green ink). The summary score is the total number of naming errors on trial 3.

Self-Ordered Pointing Test (SOPT)

This measure of spatial working memory is the variant employed by Petrides and Milner (1982) in their study of adults with frontal lobe lesions. Participants are presented with a binder composed of 36 pages divided into 4 sections. Each page contains a set of drawings and no drawing is repeated in a set. The same pictures are repeated on each page but in differing temporal position. Participants are instructed to go through the pages and point to a different picture on each page. The goal is to have pointed to all the pictures by the end of the section without repeating any pictures. Participants are discouraged from using a strategy where they point to the same spatial location on consecutive pages. The 4 sections of the booklet contain either 6, 8, 10, or 12 pages with 6, 8, 10, or 12 pictures per page respectively. Each section is administered three times. Each time the same section is administered the participant is required to begin with a different picture than on previous trials. The number of errors in each section is recorded and then added to produce a total error score.

Verbal Fluency

For this task, subjects must say aloud as many words as they can that begin with a given letter (i.e., F, A, S) within a one minute period (Benton, Hamsher, & Sivan, 1983). The subject is cautioned that proper names are not allowed, and that they are to avoid using the same word again with a different ending (e.g., 'eat' and 'eating').

Results

Participants

Mean age for the forty-five participants was 38.9 years (SD = 8.89 , Range = 22-66). Mean IQ was 94.86 (SD = 11.05, Range = 72-129). There were 37 males and 8 females in the study. Mean years of education was 11.6 (SD = 2.29, Range = 8-21). Participants were recruited by letter through their respective facilities, or through a support worker in the case of the participants in the local community. Participants were classified into either mild-moderate, or severe TBI groups on the basis of GCS score, PTA, or LOC depending on which were available (see Table 1 for severity classification). Where more than one indicator of severity was available, severity was classified using the indicator that provided the most severe classification. This resulted in the classification of subjects as 19 mild-moderate TBI and 26 as severe TBI.

Table 1.

Classification of Mild, Moderate and Severe TBI

TBI Classification	GCS	Length of PTA	Duration of Coma
Mild	13 or greater	60 minutes or less	20 minutes of less
Moderate	9 to 12	1 to 24 hours	less than 6 hours
Severe	less than 9	Over 24 hours	over 6 hours

Note. Adapted from Neuropsychological Assessment (3rd ed.), (p. 173, 755), by M. D. Lezak, 1995, New York, Oxford University Press.

In terms of mean differences on variables among the four sources of participants, the North Alberta, Victoria and Skeleem samples were significantly different from the Ponoka sample in terms of time post-injury, with the Ponoka sample averaging longer time post-injury compared to the other three groups ($p = .001$; $p = .048$, respectively). However, the four groups did not differ significantly in terms of mean age, IQ, or years of education.

Data Screening

Prior to analysis, all measures in the data set used were examined for correct entry of data, any missing values, and to ensure that the properties of the variables met with the assumptions of analyses. The data set was incomplete for some participants. One multivariate outlier was identified (Tabachnick & Fidell, 1996). Analyses in which this outlier effected results were conducted a second time excluding the data for that case from the analysis. In terms of skewness and kurtosis, none of the variables deviated significantly from normality.

Demographic Variables

The association between abilities assessed by the experimental measures and the demographic variables, collected from participant files, was explored using regression analysis. The results revealed that there were no significant effects for gender (p values ranged from .18 to .96), years of education (p values ranged from .20 to .99), time post-injury (p values ranged from .21 to .99) or severity (p values ranged from .07 to .89).

FLOPS: Reliability of the scale

To examine the reliability of the FLOPS subscales, Cronbach's Alpha for each subscale was calculated for both the self and collateral ratings (shown in Table 2 below). Collateral pre-injury ratings were available for only a smaller subsample of the total subjects tested (n=18). Split-half (Gutman) reliability for the total scale (46 items) were conducted and are shown in Table 2.

Table 2.

Reliability Coefficents for FLOPS Subscales

FLOPS scale	Self Rating		Collateral Rating	
	Before	After	Before	After
Flops Total				
Dorsolateral	.74	.87	.85	.87
Orbital	.75	.72	.83	.84
Medial	.53	.75	.81	.83

Intercorrelations among FLOPS subscales

Intercorrelations among the FLOPS post-injury subscale rating by patients and collaterals are presented in Table 3 below.

Table 3

Correlations Between FLOPS Self and Collateral Post-Injury Ratings

Variable	1	2	3	4	5	6	7	8
1. SAD	--							
2. SAM	.47*	--						
3. SAO	.75**	-.37	--					
4. CAD	-.01	-.25	-.16	--				
5. CAM	.35*	.45*	.11	.15	-- .			
6. CAO	.07	.05	.14	.22	.19	--		

There were significant intercorrelations among the three FLOPS subscale post-injury self-ratings of the brain-injured participants. By contrast, there were no significant correlations among subscale post-injury ratings provided by collaterals.

Differences between pre and post-injury ratings on the FLOPS

Analyses examining the pre and post-injury ratings on the FLOPS by both patients, collaterals, and the discrepancy between these two sources of ratings were evaluated through a series of t-tests.

Patient pre and post-injury FLOPS rating differences

Patients rated themselves as significantly impaired post-injury compared to pre-injury self-ratings across all subscales of the FLOPS. This was the case for the

Dorsolateral (t (1,45) = 5.98, p = .001), Medial (t (1,45) = 7.91, p = .001), and Orbital (t (1,45) = 3.14, p = .003) subscales. As shown in Table 4, Mean differences between pre and post-injury ratings, however, were numerically quite small (Range: 0.30-0.78).

Table 4.

Means and Standard Deviations for Patient self-ratings FLOPS subscales.

FLOPS Subscales	Before		After	
	Mean	SD	Mean	SD
Dorsolateral	1.66	.57	2.26	.69
Medial	1.56	.52	2.34	.61
Orbital	1.66	.60	1.96	.50

Collateral pre and post-injury FLOPS rating differences

Collaterals rated patients as significantly impaired post-injury compared pre-injury status across all subscales of the FLOPS. Mean differences between pre and post-injury ratings, however, were numerically quite small. Table 5 shows the mean and standard deviations of these ratings. Mean differences were somewhat greater (Range: 1.12-1.61). The following results were obtained: Dorsolateral (t (1,17) = 6.60, p = .001), Medial (t (1,17) = 8.44, p = .001), and Orbital (t (1,17) = 6.12, p = .003) subscales.

Table 5.

Means and Standard Deviations for Collateral ratings FLOPS subscales.

FLOPS Subscales	Before		After	
	Mean	SD	Mean	SD
Dorsolateral	1.55	.34	2.84	.79
Medial	1.29	.21	2.91	.77
Orbital	1.37	.28	2.49	.72

Patient-collateral discrepancy differences on FLOPS, pre and post-injury

No significant differences between were found between self and collateral ratings on pre-injury ratings across the three FLOPS subscales: Dorsolateral (t (1,16) = 1.56, p = .137), Medial (t (1,16) = .45, p = .65), and Orbital (t (1,16) = .35, p = .72) subcales. .

In contrast, collaterals rated patients as significantly different post-injury compared to patient post-injury self-ratings across all subscales of the FLOPS: Dorsolateral (t (1,44) = 4.10, p = .001), Medial (t (1,44) = 3.47, p = .001), and Orbital (t (1,44) = 3.97, p = .001) subcales. Mean differences between self and collateral across the three FLOPS subscales are shown in Table 6. Mean differences between pre and post-injury ratings, however, were numerically quite small (Range: 0.36-0.59).

Table 6.

Means and Standard Deviations for Collateral and Patient Post-Injury ratings across FLOPS subscales.

FLOPS Subscales	Collaterals		Patients	
	Mean	SD	Mean	SD
Dorsolateral	2.86	.68	2.26	.70
Medial	2.70	.74	2.34	.61
Orbital	2.43	.68	1.96	.50

Correlations between FLOPS collateral post-injury ratings and test performance

Contrary to hypothesis, there were no significant correlations between any frontal measures and collateral ratings on the three FLOPS subscales (see Table 7).

There were correlations amongst the frontal/executive functioning measures (i.e., SOPT/GoNoGo; Stroop Errors/Word Fluency) and these were in the expected direction. In addition, there were significant correlations between general conceptual ability (FSIQ) and performance on two of the four neuropsychological measures of frontal functioning (Word Fluency and SOPT).

Relationship of Neuropsychological Tests and FLOPS subscales

In order to determine whether performance on the neuropsychological measures of frontal functioning (Go/NoGo, SOPT, Stroop, Verbal Fluency) were related to FLOPS collateral ratings, a multivariate multiple regression was performed with the FLOPS collateral subscales ratings (Dor, Orb, Med) as the dependent variables, and the Go/NoGo, Verbal Fluency, Stroop and SOPT as predictors.

Table 7.

Correlations Between FLOPS Collateral Post-Injury Ratings and Frontal Measures

Variable	1	2	3	4	5	6	7	8
1. CAD	--							
2. CAM	.15	--						
3. CAO	.22	.19	--					
4. SOPT	.18	-.25	-.072	--				
5. Go/NoGo	.17	-.08	.066	.33*	--			
6. Stroop Errors	-.23	-.04	-.090	-.31	.00	--		
7. Word Fluency	-.28	.19	.152	-.20	-.07	-.47**	__	
8. FSIQ	-.03	.07	.222	-.53**	-.16	.229	.491**	__

Note, n= 45. Two-tailed p's are denoted by * =.05, ** = .01

The overall omnibus relationship between FLOPS subscale ratings and the predictor variables was not significant (F,(12, 87.6) = 0.736, p = 0.712, shrunken R^2= 0.0). In order to determined the relationship between neuropsychological test performance and FLOPS collateral ratings, independent of the influence of general conceptual ability, the same multivariate regression was conducted, but with IQ partialled from both the dependent and independent variables. Again, the overall omnibus relationship was not significant (F,(12, 86.6) = 0.1, p = 0.72, shrunken R^2= 0.0)

A series of univariate regressions were run to examine the relationship between the neuropsychological test performance and each of the FLOPS collateral subscales independently (Dor, Orb, Med). For each of these regressions, one of the three FLOPS subscales served as the criterion variable. In addition, the relative contributions of the remaining two FLOPS subscales were partialled out. Without partialling IQ, none of these regressions were significant. Even with the influence of general conceptual ability was removed from both independent and dependent variables, none of the regressions proved to be significant.

An identical series of multivariate and univariate analyses was conducted using patient self-ratings. None of the multivariate or univariate analyses were significant.

A third series of analyses examined the relationship between neuropsychological variables and ratings across the entire FLOPS scale (FLOPS-Total). These were conducted for both self and collateral ratings, with and without partialling general conceptual ability. None of the relationships proved significant.

Direction of association between awareness and neuropsychological measures

Correlations between the FLOPS self-collateral discrepancy and performance on the tests of executive functioning were examined to test the hypothesis that severity of impairment as predicted by the FLOPS self-collateral difference score would be associated with poorer performance on neuropsychological measures. The FLOPS self-collateral subscale and overall difference score score were not significantly associated with any of the neuropsychological variables.

In order to evaluate the relative contributions of the neuropsychological measures of frontal functioning (Go/NoGo, SOPT, Verbal Fluency, Stroop) to prediction of the degree of unawareness of deficit, a multivariate multiple regression was performed with the self-collateral discrepancy scores (DORADIF, MEDADIF, ORBADIF) for the FLOPS subscales ratings (Dorsolateral , Medial, Orbital) as the dependent variables, and the Go/NoGo, Verbal Fluency, Stroop and SOPT as predictors. The regression revealed no significant relationships among neuropsychological variables and FLOPS discrepancy scores. For this analysis, it was found that one subject's data contributed an undue amount of leverage. Thus, the analysis was run again with this subject removed. Again, no significant results were found. Controlling for variations in subjects' general level of cognitive ability did not change these findings.

Finally, an overall self-other discrepancy score was generated by calculating the mean difference between self and collateral ratings across the entire 46-item FLOPS scale. A multiple regression, with this overall discrepancy (FLOPS-TOTAL DIF) as the dependent and the Go/NoGo, Verbal Fluency, Stroop and SOPT as predictors proved to be nonsignificant. This was the case with and without IQ partialled and with the removal of the case with undue leverage.

In order to evaluate the hypothesis that, after controlling for general conceptual ability, the orbitofrontal scores (i.e. reversal Go/No Go, Stroop) would be a more significant predictor of the FLOPS TOTAL self-other discrepancy scores than the dorsolateral predictor (SOPT) or medial predictor (VERBAL FLUENCY). To test this hypothesis, the aforementioned variables were entered into a multiple regression analysis such that the predictive value of the individual variables could be examined. The results of this analysis were non-significant.

FLOPS Ratings from Present Study and data from the Grace et al. (1999) study

For the purposes of comparison, Tables 8 and 9 show the mean and standard deviations of post-injury ratings on the FLOPS subscales for collateral and self raters, respectively. An examination of the mean ratings show that both collatoral and self-ratings of the TBI patients are much closer to those of the frontal patients than the controls or other clinical groups from the Grace et al (1999) study.

Table 8.

Comparison of Mean (± SD) Collatoral Post-Injury FLOPS-Total ratings: Present study and Grace et al. (1999) study

	Present Study	Grace et al. (1999) data			
Collateral Rating	TBI	Frontal	Controls	Bipolar	Unipolar
Total	123.0 (±21.40)	120.0 (±29.1)	66.4 (±14.6)	90.0 (±22.6)	79.1 (15.6)
Medial	37.5 (±10.01)	40.5 (±11.3)	20.6 (±4.9)	26.4 (±9.3)	23.8 (7.2)
Orbital	36.0 (±10.32)	32.2 (±9.1)	20.3 (±4.2)	28.1 (±6.9)	23.7 (5.6)
Dorsolateral	48.6 (±11.60)	47.7 (±14.5)	25.5 (±7.5)	35.6 (±10.4)	31.6 (7.2)

Table 9.

Comparison of Mean (± SD) Self-Rated Post-Injury FLOPS-Total ratings: Present study and Grace et al (1999) study.

	Present Study	Grace et al. (1999) data			
Self Rating	TBI	Frontal	Controls	Bipolar	Unipolar
Total	101.00 (±23.12)	115.6 (±10.9)	67.1 (±13.7)	98.8 (19.1)	86.1 (±17.7)
Medial	32.87 (±8.51)	37.9 (±7.7)	20.5 (±4.5)	31.28 (±7.7)	30.6 (±6.9)
Orbital	29.56 (±7.69)	34.9 (±7.4)	21.6 (±4.1)	29.8 (±7.2)	24.8 (±4.1)
Dorsolateral	38.53 (±11.82)	42.9 (±4.3)	24.5 (±6.4)	37.7 (±8.2)	30.7 (±8.7)

Neuropsychological test performance: data from present and previous studies

Table 10 presents a comparison of selected neuropsychological test data from the present study and comparable data from previous published research. Data for the following tests were available: SOPT (Daigneault et al. (1992); Verbal Fluency (Tombaugh, Kozak, & Rees, 1996), and the Stroop test (Bullock, Brulot, & Strauss, 1996). In all cases, the mean age of the participants were comparable to those of the present study. A series of t-tests were conducted to evaluate mean differences between the TBI subjects in the present study and normal controls from other published studies. TBI subjects demonstrated poorer performance on three of the four measures of executive functioning (SOPT: $t(113) = 1.66$, $p < .0001$); Verbal Fluency: $t(311) = 1.65$, $p < .0001$); Stroop Total Time: $t(56) = 1.70$, $p < .0001$).

Table 10.

Comparison of selected neuropsychological test data from the present study and comparable data from previous published research.

Test	TBI subjects	Normal Controls (Other Studies)
SOPT-Total Errors	24.9 (±7.58)*	15.2 (±6.22)[1]
Verbal Fluency (FAS) Total	28.0 (±14.0)*	40.5 (±10.7)[2]
Stroop Total Time	52.7 (±13.7)*	27.20 (±8.15)[3]
Stroop Total Errors	3.2 (±2.2)	.78 (±.88)[3]

* $p < .0001$ vs controls
1. Daignault et al., 1992
2. Tombaugh, Kozak & Rees, 1996
3. Bullock, Brulot & Strauss, 1996

Discussion

The primary purpose of this study was to evaluate whether distinct frontal lobe personality syndromes, as described in recent anatomical-functional models, could be found in a population of adult traumatic brain-injured participants using a recently developed questionnaire, the Frontal Lobe Personality Scale (FLOPS). This questionnaire has demonstrated some ability to discriminate among groups of patients with and without compromised frontal lobe function in previous studies. A second purpose of this study was to evaluate whether putative subsystem-specific measures of frontal/executive functioning (dorsolateral, orbital, and mesial frontal subsystem, respectively) were correlated in a *unique* manner with specific frontally-based personality sub-types as indexed by the FLOPS questionnaire. Third, an attempt to replicate previous findings of reduced awareness of deficit among traumatically brain-injured patients was made. Finally, the question of whether tests of executive functioning could predict the degree of unawareness of deficit among brain-injured patients, over and above measures of general conceptual ability, was examined.

To evaluate these hypotheses, information was collected via neuropsychological tests of executive function, general conceptual ability, and a questionnaire of frontally-based personality change (FLOPS).

Reliability of the FLOPS subscales

Moderate reliabilities were found for the collateral ratings on the FLOPS subscales both pre and post-injury. As noted earlier, collateral pre-injury ratings were available for only a smaller subsample of the total subjects tested (n=18). In contrast, the reliabilities for the self-ratings on the subscales were somewhat lower, particularly on self-ratings of pre-injury status. One possible interpretation of this result is that, as a group, the traumatically brain injured participants are poorer at the task of evaluating both their pre-injury and post-injury behavior/personality characteristics. It is interesting to note that Grace et al. (1999) also found lower subscale reliabilities in the patient self-report ratings compared to collaterals.

An examination of the correlations between pre and post ratings by collaterals suggested that current behavior of the brain-injured patients did not appear to unduly influence retrospective collateral ratings of pre-morbid baseline behavior. There were no significant correlations between pre and post ratings by collaterals indicating that these raters were able to rate the patient's behavior independently for each time point. These findings are consistent with the Grace et al. (1999) study.

Unlike collaterals, however, TBI patients post-injury self-rating appears to have been biased by their recollections of their pre-injury status. Patients' pre and post self-ratings on the FLOPS were significantly correlated. This was the case for each of the three subscales (DOR , ORB, MED). Again, this is consistent with the Grace et al. (1999) study.

There are a number of reasons why TBI participants demonstrated lower reliabilities on the FLOPS compared to those provided by collaterals. The TBI participants may under-rate their deficits in certain areas while over-rating them in others. This could occur because they are constantly confronted with their limitations in some areas (e.g. physical disabilities) but not by their more subtle cognitive or emotional deficits. Additionally, they may respond non-systematically because of the interaction between their cognitive deficits and their approach to the questionnaire. Different combinations of deficits may result in different response patterns. As a result, their approach to completing the FLOPS may be highly variable.

Overall, these findings would suggest that greater degree of confidence can be placed in collateral ratings on the FLOPS. For this reason, subsequent analyses with neuropsychological variables were restricted to the collateral ratings on the FLOPS.

Intercorrelations between FLOPS subscales

There were significant intercorrelations among the three FLOPS subscale post-injury self-ratings of the brain-injured participants. By contrast, there were no significant correlations among subscale post-injury ratings provided by collaterals. These findings are puzzling. They suggest that there are significant differences in the manner in which both patients and collaterals see the inter-relationship among the personality and behavioral descriptions addressed by the FLOPS subscales. Whereas patients appear to rate themselves in a consistent manner across all three subscales, collaterals appear to make greater differentiation among these scales.

Post-Injury FLOPS-Total ratings: Present study and Grace et al. (1999) study.

One question that arises is whether subjects in the present study have comparable FLOPS ratings to frontally-compromised patients in the study conducted by Grace et al. (1999). Although no formal statistical analyses can be made, the data suggest that the present TBI sample have comparable collateral and self ratings on the

FLOPS. Specifically, the TBI sample's collateral and self ratings show large mean differences compared to the normal controls in the Grace et al. (1999) study. These comparisons provide some support, albeit not strictly empirical, for the conclusion that the FLOPS appears to be tapping frontally-based behavior and personality changes in the TBI sample in a similar manner as that found by Grace et al. (1999).

Relationships among neuropsychological variables and the FLOPS

The present study was unable to provide any support for the hypothesis that post-injury ratings on the FLOPS would be related to measures of neuropsychological functioning. None of the neuropsychological variables, including measures of general intellectual ability, were significantly related to self or collateral ratings on the FLOPS questionnaire.

Given that the neuropsychological measures of frontal functioning used in the present study have been validated in previous studies would argue against the conclusion that these measures are simply poor at assessing deficits in frontal/executive functioning.

The lack of a significant relationship between neuropsychological variables and post-injury ratings on the FLOPS may be due to a number of factors. One possible explanation for the lack of significant findings may lie in the population of interest in this study. Although it is generally held that frontal lobe damage is a frequent consequence of closed head injury, no "gold standard" of frontal lobe damage was available for the participants in this study. Given the lack of imaging data on the possible location of neurological injury in these subjects, it is conceivable that focal frontal deficits may simply not be present in the current sample. Rather, the neurological injuries sustained by this population may be more diffuse, thus precluding the possibility of a clear relationship between frontal lobe functioning and behavioral ratings.

The question arises as to whether the current TBI sample demonstrated actual deficits on the tests of frontal lobe functioning. Although data from normal controls was not collected, a comparison of the performance of the present TBI sample to that of normals collected in previous studies (Table 10) provides some evidence that the TBI sample indeed demonstrated significant deficits in frontally-based cognitive functioning in comparison to normal controls.

Differences between pre and post-injury ratings

At first glance, the results of the present study would appear to support the literature on reduced awareness of deficit in traumatically-brain injured populations. Specifically, there appears to be a statistically significant discrepancy between patient and collateral post-injury ratings with collaterals' ratings, as a group, indicating greater change in personality and behavior following injury. However, the analyses that examined pre versus post-injury status in the patient group would appear to contradict this finding. That is, patients' self-ratings on the FLOPS suggest a statistically significant change from pre-injury status. Taken as a whole, these findings indicate that, where patients and collaterals differ is in the *magnitude* of personality and behavior change as indexed by the FLOPS. That is, patients appear to be well aware of the changes in their post-injury personality and behavior functioning but do not consider it to be as large as the collateral raters did. Importantly, these findings are in line with the results of the Grace et al. (1999) study in which both patient and collaterals acknowledge a change from pre-injury status on the FLOPS.

Finally, this study sought to investigate whether significant correlations would be found between measures related to frontal lobe functioning and awareness of deficit as indexed by the degree of discrepancy between self and collateral ratings on the FLOPS. No significant relationships were found.

Grace et al. (1999) state that the FLOPS was developed as a brief measure of common behavioral problems that are observed after frontal lobe damage. One of the main goals for the development of the FLOPS was to provide clinicians with a psychometrically sound tool to quantify behavioral and personality variables that are often only noted through clinical observation and interview with clients. However, the clinical utility of this instrument must also be further examined. Specifically, it is unclear whether the current three subscale version which is based upon current clinico-anatomical models of frontal lobe subsystem functioning is the best method of classifying frontally-based behavior and personality change *in a clinical setting*. From a clinician's perspective, it may be less important to make such clinico-anatomical distinctions and more important to gain a greater sense of a client's functional status across a wider variety of domains of functioning.

Although, in the present study, the results do not lend support to the notion that the FLOPS taps, in a qualitative manner, any of the frontal deficits seen on tests of frontal lobe functioning, it remains, at present, the only clinical and research tool that allows one to examine the three separate frontally-based personality syndromes as outlined in recent clinicoanatomical models. Further research with different clinical populations with compromised frontal functioning will be needed in order for FLOPS to demonstrate its usefulness as a viable instrument in helping investigators gain greater understanding into what Teuber (1964) called “the riddle of the frontal lobes”.

Appendix 1: Frontal Lobe Personality Scale

FL PERSONALITY SCALE
J. Grace & P. Malloy

Patient Version

	Before	Current
A:		
D:		
E:		

Instructions: Below is a list of phrases used to describe someone. How well do each of these descriptions characterize you for each time point? Place a number in each box which corresponds to your rating for each point in time.

Use this rating scale for each point in time:

1 = Almost Never

2 = Seldom

3 = Sometimes

4 = Frequently

5 = Almost Always

Here is an example:

	Before injury or illness	At the present
I avoid going to the doctor	5	5
1. I speak only when spoken to		
2. I am easily angered or irritated, I have emotional outbursts without good reason		
3. Repeat certain actions or get stuck on certain ideas		
4. I do things impulsively		
5. Mix up a sequence, get confused when doing several things in a row		
6. Laugh or cry too easily		
7. Make the same mistakes over and over, do not learn from past experience		
8. Have difficulty starting an activity, lack initiative, motivation		
9. Make inappropriate sexual comments or advances, am too flirtatious		
10. Do or say embarrassing things		
11. Neglect my personal hygiene		

1

1=Almost Never
2=Seldom
3=Sometimes
4=Frequently
5=Almost Always

	Before injury or illness	At the present
12. Can't sit still, am hyperactive	☐	☐
13. Am unaware of my problems or when I make mistakes	☐	☐
14. Sit around doing nothing	☐	☐
15. Am disorganized	☐	☐
16. Lose control of my urine or bowels and it doesn't seem to bother me	☐	☐
17. Cannot do two things at once (for example, talk and prepare a meal)	☐	☐
18. Talk out of turn, interrupt others in conversations	☐	☐
19. Show poor judgement, poor problem solver	☐	☐
20. Make up fantastic stories when unable to remember something	☐	☐
21. Have lost interest in things that used to be fun or important to me	☐	☐
22. Say one thing, then do another thing	☐	☐
23. Start things but fail to finish them, "peter out"	☐	☐
24. Show little emotion, am unconcerned and unresponsive	☐	☐
25. Forget to do things but then remember when prompted or when it is too late	☐	☐
26. Am inflexible, unable to change routines	☐	☐
27. Get in trouble with the law or authorities	☐	☐
28. Do risky things just for the heck of it	☐	☐
29. Am slow moving, lack energy, inactive	☐	☐
30. Am overly silly, have a childish sense of humor	☐	☐
31. Find that food has no taste or smell	☐	☐
32. Swear	☐	☐

NEW INSTRUCTIONS:

> **Now use this rating scale for each point in time:**
>
> **1 = Almost Always**
>
> **2 = Frequently**
>
> **3 = Sometimes**
>
> **4 = Seldom**
>
> **5 = Almost Never**

	Before injury or illness	At the present
1. Apologize for misbehavior (for example, apologize for swearing)	☐	☐
2. Pay attention, concentrate even when there are distractions	☐	☐
3. Think things through before acting (for example, consider my finances before spending money)	☐	☐
4. Use strategies to remember important things (for example, writes notes to myself)	☐	☐
5. Am able to plan ahead	☐	☐
6. Am interested in sex	☐	☐
7. Care about my appearance (for example, daily grooming)	☐	☐
8. Benefit from feedback, accept constructive criticism from others	☐	☐
9. Get involved with activities spontaneously (such as hobbies)	☐	☐
10. Do things without being requested to do so	☐	☐
11. Am sensitive to the needs of other people	☐	☐
12. Get along well with others	☐	☐
13. Act appropriately for my age	☐	☐
14. Can start conversations easily	☐	☐

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